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DOM ix Dimple key system.

I have read the article of Bob Dix with great interest. As a collector and “specialist” of European high security (pad)locks. I would like to delve deeper into the mechanics of locking systems and explore the development of several high security systems. I have examined the locking systems of most European manufacturers including Kaba, ASSA, BKS, Wilka, Winkhaus, Mul-T-lock, etc. It has been interesting for me to witness the progression in these manufacturers evolving security features. This perspective has been gained as I am a serious security hardware collector, with currently in excess of 1900 locks in my collection.

I have decided to write about the history of the German DOM ix system, because this manufacturer came with one of the first reversible dimple key systems with a horizontal keyway.

DOM is also one of the world's leading manufacturers in security technology. Personally, I also find that DOM produces high standard quality security locks. The quality of materials, processing and function can be taken for granted.

First some history, Josef Voss founded in 1936, a trading company in Cologne. This company grew into the DOM as we know it today. In 1946 DOM started with the production of industrial cylinders and in 1970, DOM introduced its first reversible key system, the DOM ix. In that time frame, it was a revolutionary design as everybody was accustomed to “normal” pin-tumbler keying systems.

Ultimately, DOM has become a part of the ASSA Abloy group

The DOM ix-10

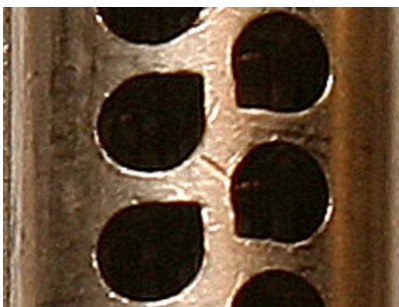
The first ix keys had 2 rows of 5 pin tumblers which are arranged in an offset position relative to each other. The key had a flat profile and could be used reversibly. At the top of the key there was a groove for the profile. The top of the key was not beveled as is the case with modern ix-locks. Furthermore, this was also one of the first keycard secured cylinders. The lock in this picture was from a Master Key system, on the nickel-silver key was stamped HS (Haupt Schlüssel) meaning Master key. There are 10 streamlined top large diameter pins in this cylinder.



One of the first DOM ix-10 cylinders

Something about the pins

The pins in a DOM are not allowed to rotate in the chamber; thus they have a sharp edge over their full length preventing them from rotating in their respective chambers.

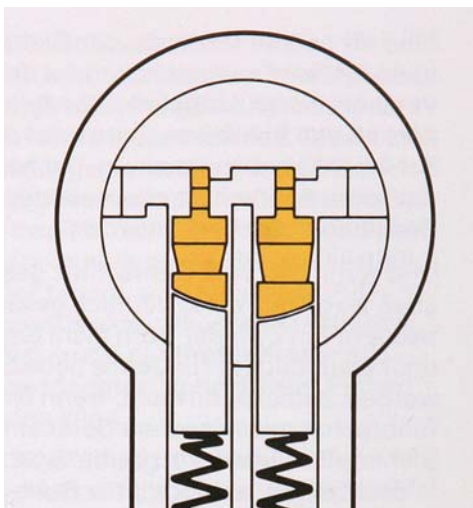


Top view of a chamber in the plug, to show the edge and shape of the pins

The pins in the plug which interface with the cylinders shear line must have the same profile as their mating housing. So the specific pins can only be used in either the left row or the right row in the cylinder plug. This is due to the part of the pin which makes contact with the key is streamlined in the way that you can insert the key. A few pictures further into this article, you will get to see the specific top of the lower pins.

In ordinary pin tumblers the bottom of the lower pin is non critical, as the chamber for the pin is in the middle of the plug, the radius on the top of the pin is then symmetrical, these pins may also rotate as this creates no difference in pin length. In the case of the ix-system the effective length would be changed due to rotation.

On the next picture you can imagine what should happen if you should replace the lower pin from the left row in the right row (and vice versa).



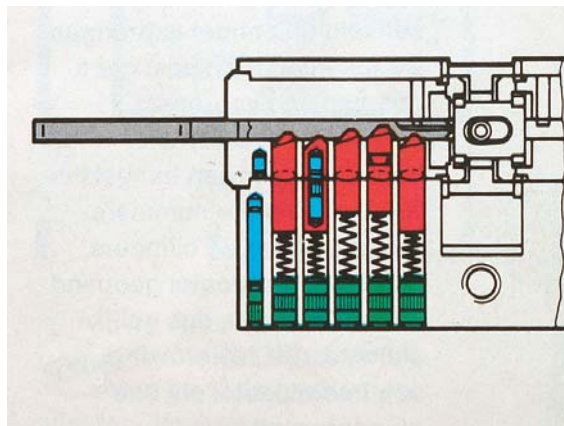
Cross-section of the plug to show the contact points with the shearline
(the contact points from the pin with the key, are from a later version DOM)

Some old key profiles

Later on DOM improved upon their system by making an extra groove in the top, on both sides (left and right side) of the key. This made it harder to make unauthorized copies. In the following picture, you can also see some different key profiles from prior designs. Some of these profiles were used for GMK (Grand Master Key systems).



3 different old ix-10 key profiles with extra grooves on the left and right side of the key (not visible).



Side view of the DOM ix cylinder, with drill-protection provision along with eccentric profile, large diameter pins.

The next step in increasing the security of the ix system was the introduction of a groove on the top and bottom of the key (for the profile) along the full length of the key. They also introduced vertical profile control pins in the cylinder; this required the creation of extra drill holes on the bottom and top of the key. Up to 5 passive vertical control pins were possible. These control pins are a passive, rather than a spring loaded system. If the dimple in the key is missing, the according pin is pushed out of the plug and the plug is blocked. By making 5 extra drill holes in a key, one can compromise this aspect of the locking system. The chambers for these inactive profile control pins are on the underside of the plug, because there is no space for extra chambers on the side where also the chambers for the pin tumblers are.

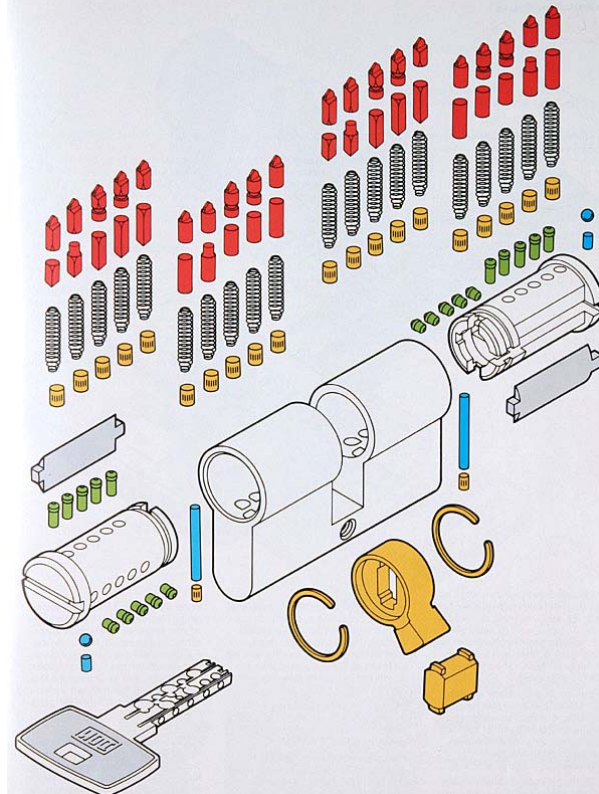
Later on DOM also came with horizontal profile control pins (extra drill holes of the side of the key). This required the key to be made broader. There are up to 5 control pins possible on the side of the key. The passive pins on the top and side of the key are mainly for GMK systems. The key below is an example of a key from a GMK system and has therefore stretched dimple holes. I assume DOM's intent of stretching the dimples was to make the keys harder to copy.



Master key with profile control pins on the bottom (2), on the side (2) and stretched dimples.

The parts in a DOM ix-10 double cylinder

The DOM ix system profile double cylinders are composed of almost 120 components which are manufactured and assembled to tolerances of only a few hundredths of a millimeter. On the picture below you can see the parts (and also the specific shape of lowerpins and toppins) in a DOM ix-10.



120 parts used in a DOM ix double profile cylinder

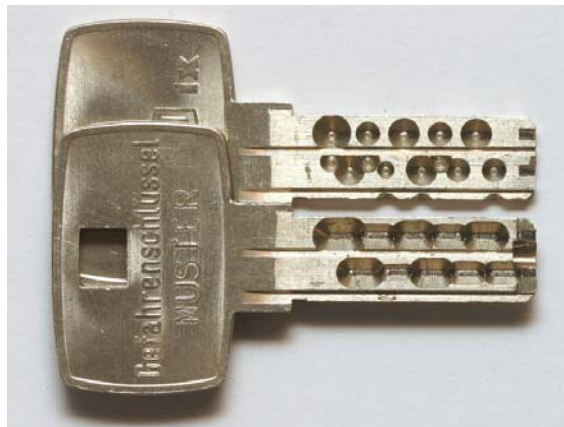
The Emergency key device

In Europe we use mostly Europrofile double cylinders where the inner cylinder and the outer cylinder are manufactured as one part. For security reasons, Europrofile double cylinders are normally constructed so that, when a key is in position on the inside, the cylinder cannot be opened, even by the master key in an installation. This enables the user to deny access to unwanted visitors who otherwise would have the right to enter. In exceptional circumstances, it may be necessary to operate the cylinder from the outside even when the key has been left inside. With the Emergency key you can operate the lock, even when a key has been inserted in the inside keyway.

How it works:

The key on the inside simply prevents normally the key from the outside to be inserted fully, so the pins will not be lifted correctly to create the correct shear line.

In the Emergency key (Gefährenschlüssel), the dimples are stretched and with the same cut depth as a normal key. You can insert this key 95% on the outside when there is another key on the inside. Because the dimples are stretched and have the correct cut depth, the pins are lifted correctly and the plug can rotate. By rotating it, the key flips further in the lock and you can open the cylinder. The key on the inside then rotates together with the external key.

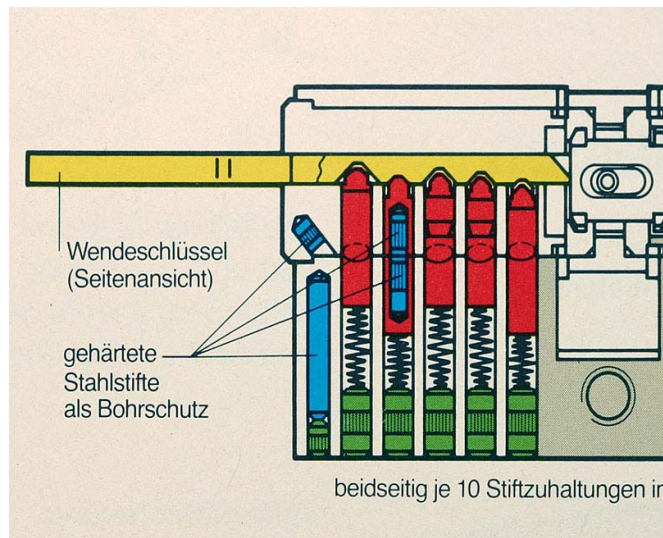


DOM ix normal key and Emergency key (Gefährenschlüssel).

However cylinders from DOM also can be supplied with the double-entry function which are used in particular where a third party who has no special Emergency key must gain access, e.g. in old peoples' homes, hospitals and blocks of flats. An additional Emergency key is not necessary then, but this is an extra feature.

Improvement of the lower pins

Another big improvement from the ix-system was the change of the top of the lower pins. *(Note: in this article, I am following the American protocol of calling the pin that contacts the key as the "lower pin". Typical European practice is for the pins to be placed at the bottom of a plug, opposite to what is the norm in the States).* Notice the top of the key where the pins touch the keys, you can see two small grooves on the top. DOM started to use the new narrow profile pins in the cylinder in order to increase its pick-resistance. It seems that it's harder to pick the lock because the surface of the pins is smaller.

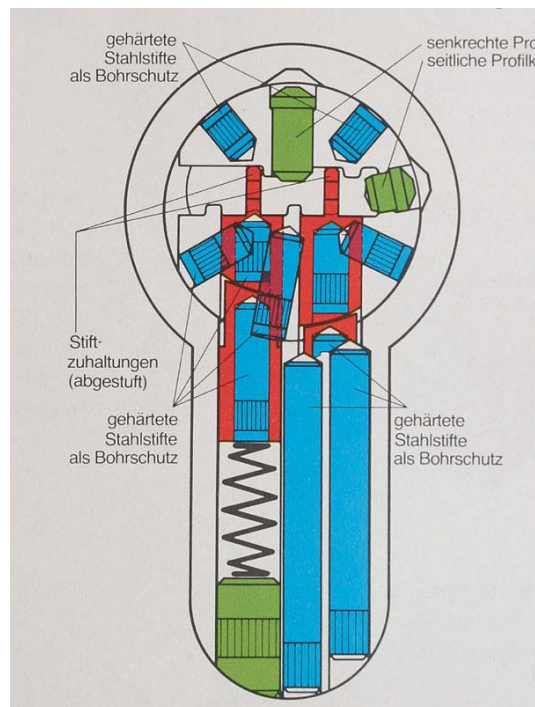


Note (smaller) contact points of lower pins

Extra drill protected version

Because this system was for decades, DOM's premier offering, they put several drill protection pins in the cylinder. On the picture you can see an example of the drill resistant version of the cylinder. In this picture, you can also see clearly the smaller top of the lower pins and the working of the horizontal and vertical control pins.

Nowadays these drill protection pins have less value, as burglars tend to pull out the cylinder with a cork-screw shaped tool.



Drillproof version of a DOM ix

All mentioned systems before are named DOM ix-10, because of the 10 active (spring loaded) pins.

The DOM ix-5 N

Because the production of a 10-pin lock with special shaped pins is more expensive than the production of an ordinary 5 or 6 pin tumbler lock, DOM introduced the cheaper 5 pin lock for normal home usage. They called the system ix-5 and this is for people who want a less expensive ix-system. This system has no extra passive pins and ordinary round pin tumblers are used in this cylinder. This system is easy to pick, and it's the most simple ix system.

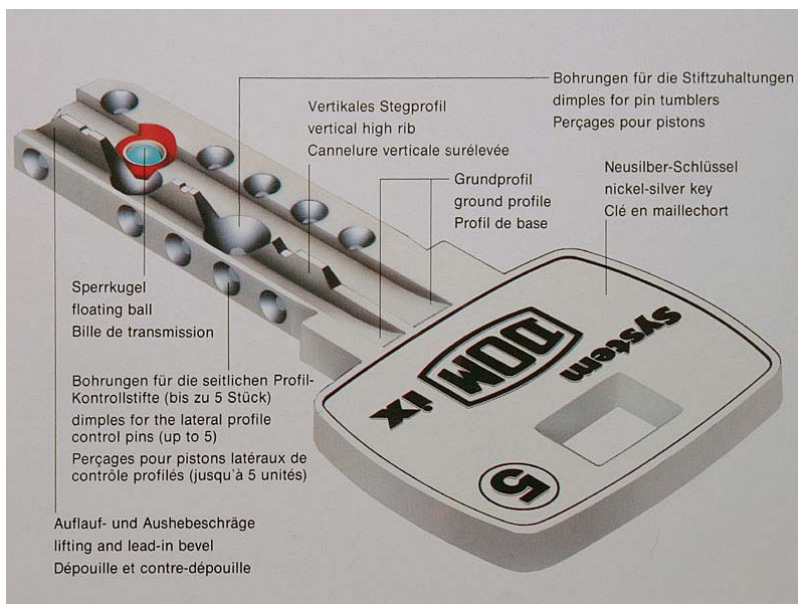


DOM ix-5 N key

The DOM ix-5 KG

To improve this reversible ix-5 system and to make it more resistant to unauthorized copying, they introduced the moveable floating ball in the top of the key for added security. 5 pin tumblers are controlled by dimples in the key, horizontal and vertical pins guarantee additional security for profile controlling.

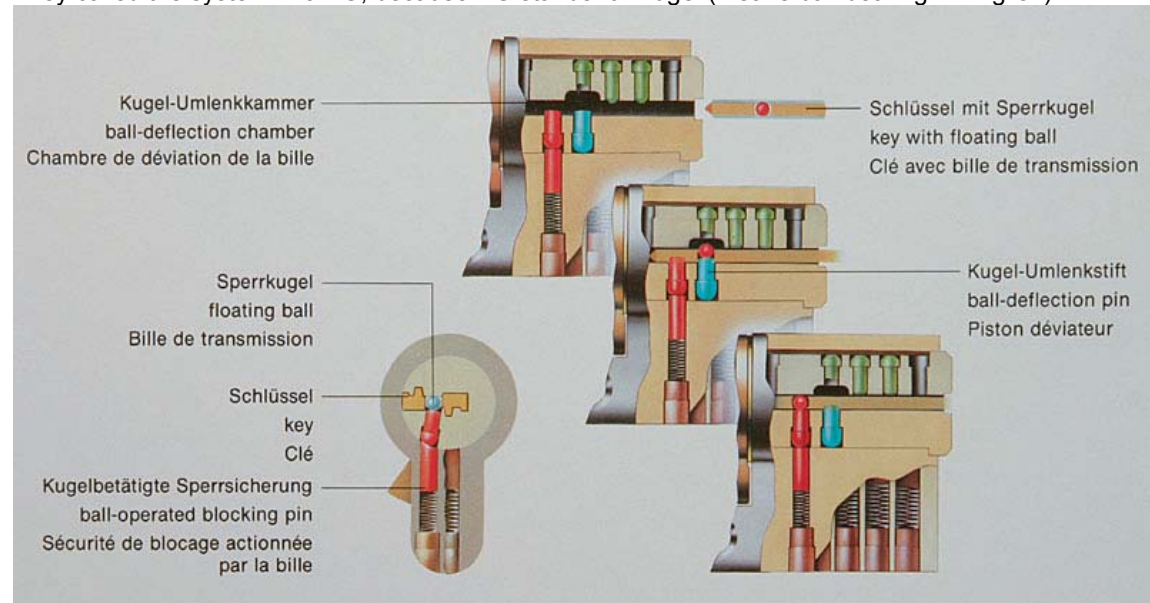
The key has a special chamber in which a floating steel ball is mounted. The ball is the only element which can move the deflection pin (which projects into the key way) and actuates the spring-loaded special tumblers arranged on each side of the lock. The special deflection chamber in the cylinder is protected against access from the outside.



DOM ix-5 KG key, with floating ball in the top of the key

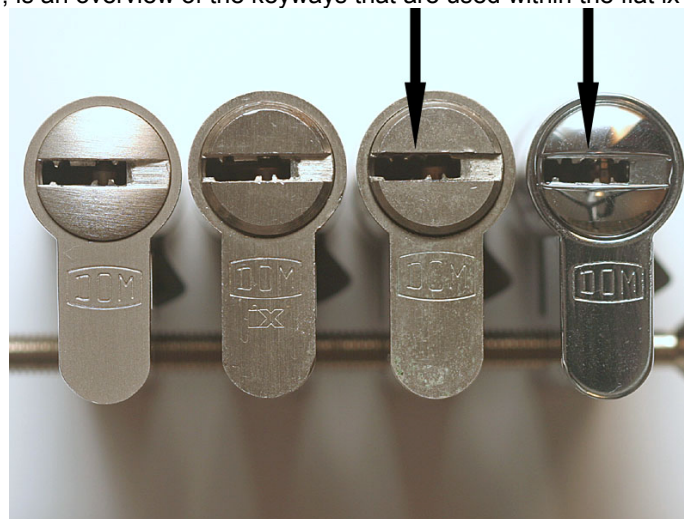
The next illustration demonstrates in three phases how the floating ball functions within the locking process inside the cylinder. When the key is inserted, the floating ball first overrides the ball deflection pin. This is a stationary steel pin which protrudes into the keyway. The space required for the ball to override the ball-deflection pin is provided by the ball-deflection chamber. The ball's mobility in its cage is just enough to enable it to override the ball deflection. Finally, the ball operates the two-part blocking device that lies behind the deflection pin. A rigid instrument cannot operate the blocking mechanism, because the deflection pin protruding into the keyway prevents it from being inserted.

They called the system ix-5 KG, because KG stands for Kugel (means ball bearing in English).



Working of the floating ball in the key in three phases

In the picture below, is an overview of the keyways that are used within the flat ix-5 KG system



Front view 4 different flat DOM ix-5 (KG) keyways

On this picture you can see from the left to the right:

- DOM ix-5 (without ball-bearing)
- DOM ix-5 KG (old style keyway)
- DOM ix-5 KG, note the rounding in the keyway for the floating ball
- DOM ix-5 KG, note the rounding in the keyway+ special shaped pins

DOM made a very clever design change with the ball bearing principle; this is the reason why the keyway changed. The lock on the right is the most mature version of the ix-5 KG.

The DOM ix-5 KG high ribbed profile

The aforementioned ix-systems have all flat keys. The variety in pin length is therefore not that big, 5 or maybe 6. The non active pins were an extension of the key variety.

To increase the key variety DOM introduced the high ribbed profile. They made the rib on the key higher so that the pins could be lifted higher. This made it possible to increase the variety in pin lengths as they could now also use shorter pins. The larger variety in pins made it also possible to use masterkeypins in the cylinder for possible masterkeying.

The DOM ix-6 KG low ribbed profile

Later on they came with a new idea to use a greater variety of pins. They lowered the rib on the key, the dimples in the key could now be cut deeper and it was now possible to use longer pins. They called this the system ix-6 KG. I assume they used the 6 in the type number to mark that it's a lowered profile. The ix-6 KG system has 5 active pins and a maximum of 12 inactive pins (6 bottom and 6 sided). In the picture below, you can see the difference between an ix-5 KG and an ix-6 KG keyway (the cylinders in the middle). The key in this system can be checked at 19 contact points before it releases the cylinder.



Front view - Raised keyway DOM ix-5 KG (old), ix-5 KG (new), ix-6 KG, ix-5HT

The DOM ix-5 HT with high-low ribbed profile

A combination of both (high ribbed profile and low ribbed profile) resulted in the ix-5 HT. These characters stand for Hoch-Tief (High-Low in English). You can recognize the system by the H-shaped keyway. This keying system uses the best of both concepts, higher rib on the key for the use of shorter pins, and lower rib, to make it possible to use longer pins. The HT system has 5 active pins and maximum of 12 inactive pins (6 bottom and 6 sided). The variety of pin length comes close to the normal pin-tumbler system. The key can be checked at 18 contact points before it releases the cylinder. This system lacks a ball-bearing within the key.

The DOM ix-5 HT with floating ball in the key?

In the week that I had to finish this article, I got a heavy Corbin / Dom padlock from France. When I saw the padlock on the picture, I thought it had a special DOM ix-5 KG profile. Taking a closer look at the key (when I had received the lock) I saw that it was a mix of the ix-5/6 KG and the ix-5 HT, because of the floating ball in the key and the high-low ribbed profile.

As you see the company DOM keeps me surprising with the systems they bring on the market. I did not see this system in any catalogue (yet). The key has a longer shaft so that the cylinder can be used in combination with a pull-out protecting escutcheon in order to prevent the cylinder from wrenching out.

On the pictures below you see the key of this before mentioned system, together with some other ix-5 keys.



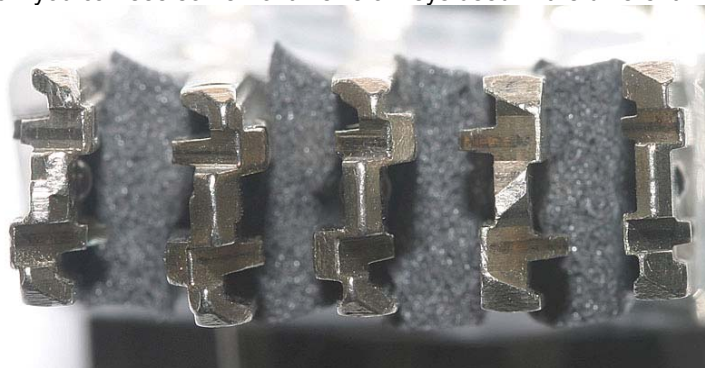
Some different DOM ix-5 keys.

From top till bottom:

- DOM ix-6 KG, you can see the low ribbed profile on the top of the key over the full length
- DOM ix-5 KG, you can see clearly the high ribbed profile
- DOM ix-HT, you can see clearly the high and low ribbed profile
- Mix of ix-5 HT / KG, you can see clearly the high and low ribbed profile and the floating ball

Note: on the Corbin / DOM key, there is no "System name" on the bow.

On the pictures below you can see some front views of keys used in the different ix-5 systems.



Front view of keys used in different ix-5 systems.

On this picture you can see clearly the place and the heights of the ribs in the different lockingsystems.

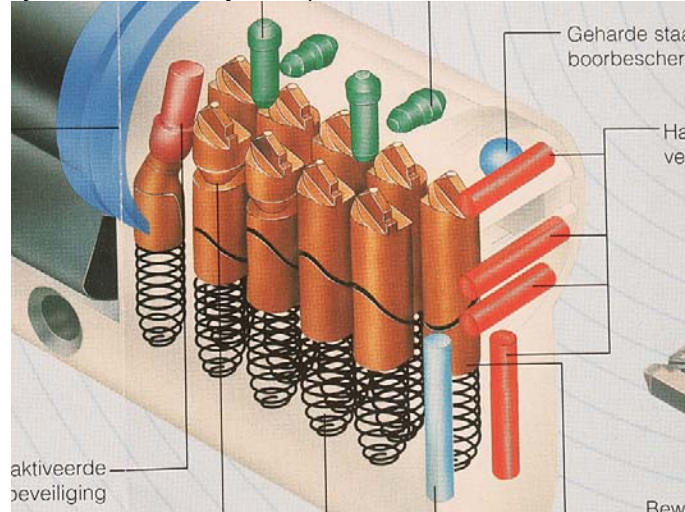
From the left to the right you see a:

- Mix of ix-HT / KG
- DOM ix-HT
- DOM ix-6 KG low ribbed profile
- DOM ix-5 KG high ribbed profile
- DOM ix-5 KG flat

The DOM ix-10 KG

You could predict the next improvement from DOM, they introduced the floating ball system in the ix-10 and now they had the DOM ix-10 KG. This system has it all, the ten pin tumblers and the vertical and horizontal profile control pins and the special chamber in the key in which a floating steel ball is mounted. This system provides DOM's highest levels of security against picking and impressioning.

In this exploded view you can see clearly inner parts of a DOM ix-10 KG, with the special shaped pins.



Exploded view of the top model, DOM ix-10 KG

It seems that the ix-10 KG was brought earlier on the market in Canada as in Europe. See below a demo cylinder that was used in America and Canada. It has the old small profile key. The floating ball in this key is not mounted on the top of the key.



DOM ix-10 KG demo cylinder with three different keys (USA / Canadian market)

Note: This cylinder comes from the collection of A.J. Hoffman

The DOM ix-10 KG with high ribbed profile

In the DOM ix-10 KG we see also two different keyways, a flat ribbed profile and a high ribbed profile. The flat ribbed profile is for mono keying, the high ribbed profile can be used in Master Key systems. You can see clearly the two rows of pin tumblers in this keyway. The DOM ix-10 KG has 10 active pins

and a maximum of 10 inactive pins (5 bottom and 5 sided). The key can be checked at 21 contact points before it releases the cylinder.



Front view flat ribbed profile and high ribbed profile

The DOM ix-10 KG is currently the top of the line of DOM's ix-series.

The DOM ix-10 KG => 2 in 1

As an extra option this keying system can be provided in the 2 in 1 version. That means that you get two complete keysets, key K1 and key K2 with one cylinder. This option can be useful after key loss, theft or uncertainty about the existence of duplicate keys. The cylinder can then be irreversibly programmed for keyset K2. Therefore you insert key K2 and rotate the plug 360°. This makes key K1 worthless. It's not possible to make key K2 from key K1, because there is less "flesh" on key 1. On the picture you see a K1 and K2 key. The "change" pins location can be random.

The methodology of this is that a ball bearing is lifted up by the lower pin when key K2 is used. This ball bearing is lifted up in the housing of the cylinder. At 90° in the plug there is a small hole, after rotating key 2, the ball bearing is pushed in this small hole, and the length of the lower pin is changed at that point. With the usage of key K1, the lower pin and the ball bearing are in the plug. When key K2 is used, only the lower pin is in the plug and the ball bearing is stored in an extra hole within the plug.



DOM ix-10 KG 2 in 1, key K1 (left) and key K2 (right)

The DOM ix-10 (KG) => Split key

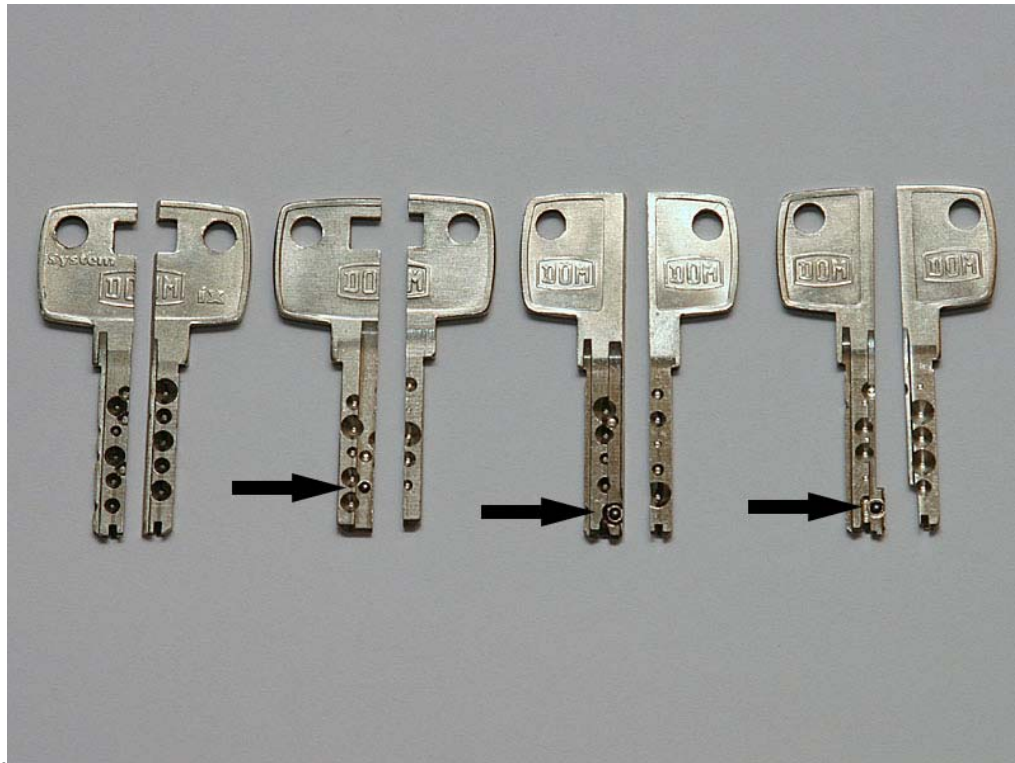
The split key comes in two halves, each half with different coding. The lock can only be operated once both keys are inserted into the lock simultaneously. DOM solves the problem of having to purchase two locks for a particular door to restrict entry. Only one lock is needed for a door while two split keys are required to open the lock.

I did have a close look at the cut side of these keys and I conclude that the split-key is made out of one key. I assume they make one ordinary key and then they part it with a water jet cutting system. I currently have 4 split-key sets in my collection and I must say they are all different.

The key on the left is a DOM ix split key from the first generation.

The key right from that one is an older American/Canadian DOM ix-10 KG split key, you can recognize that it's an older KG system, because the key is smaller and the floating ball is not on the top of the key (see arrow).

The next split key is from a modern DOM ix-10 KG. Because some dimple holes of the smaller split key were also visible on the broader split key (the left half), they made both split keys the same width, so that dimples from the other key could not be read in the other split key.



4 different DOM ix-10 (KG) split keys

DOM ix in the States

A few months ago I bought this DOM ix cylinder on Ebay. I assume this kind of cylinder is used in knob cylinders in the States. When I saw the lock in the picture I was curious as to how they put two rows of pins in the housing, this was my reason for buying it. On the picture you can see that there is only one row of 5 pins in the lock.



American DOM ix-10 with only 1 row of pins

Some plugs

I took some pictures of plugs I found from the DOM ix-10 systems. The plug on the left is from a DOM ix-10. There are 10 normal ix pins in the plug. The plug in the middle is from an American/Canadian DOM ix-10 KG. The arrow marks the place where the pin is, which is controlled by the floating ball in the key. On the right you see the modern DOM ix-10 KG plug, here the chamber for the floating ball is on the top of the plug.



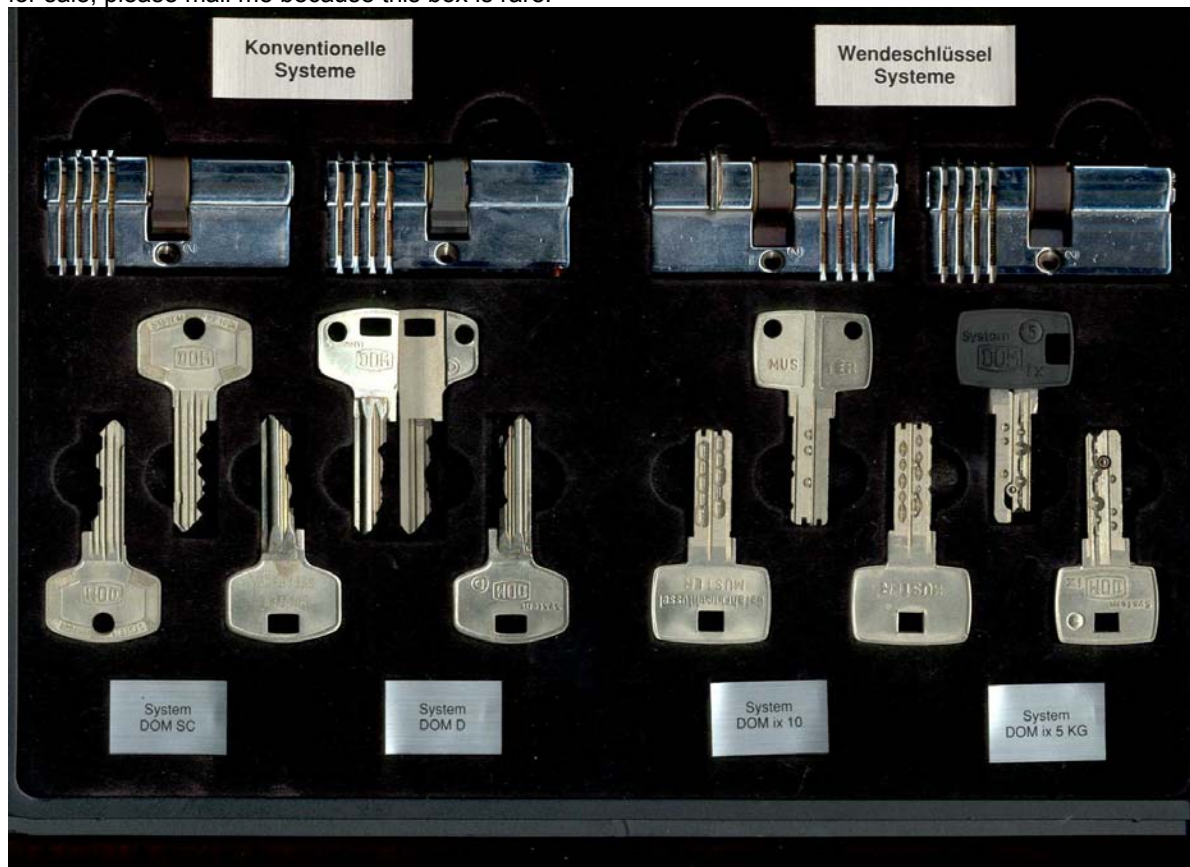
Three different plugs used in DOM ix systems.

Conclusion

The intent of this article is just to show the variety of keyways / systems which are used in the DOM ix system. I have also tried to display the progression of the system.

Beside the ix system DOM has many more locking systems, such as the systems SV, RN, RS, R-plus, RN, Diamond, etc. There is also a lot to tell about these systems, but I think that falls out of the scope of this article, may be the next time.

Finally, I include this article with a picture of an at least 10 year old DOM sales sample box. It contained all the techniques DOM had that time in their mechanical cylinders. If you ever see this box for sale, please mail me because this box is rare.



DOM sales sample box, with system SC, D, ix-10 and ix-5 KG

Note: All the keys in this box are different, for example, the keys on the left from each system are "Emergency keys". The Dom D split key I have actually never seen. I tried to order one but they are not produced anymore, just like all the parts in this box.

I hope that you enjoyed this article, and I hope to continue with the Abloy story (part 2) in the next issue. On the next link you can find the pdf-file of this article <http://www.toool.nl/dom-ix.pdf>